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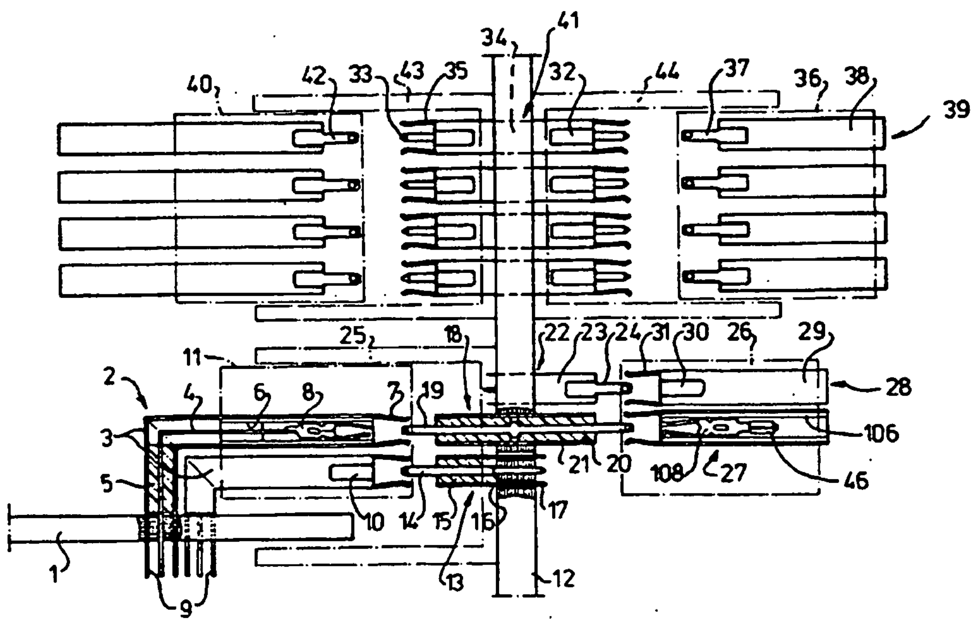

(57) Abstract

Connector system provided with connectors, each of which comprises at least one shielded terminal (for example 2, 18, 27), comprising an earth contact (for example 3, 21) and at least one signal terminal (8, 19, 108), which earth contact (3, 21) is identical for signal conductors (4) terminating either in a female (8, 108), a male structure (19) or a hermaphroditic structure and which has at least one lug (7) extending beyond the shielded terminal (2, 18, 27); the signal terminal (8, 108) is either provided, at one end, with at least one clamping lug (46) which can be folded around the signal conductor of an electrical cable to establish a firm electrically conductive contact therewith, or it is integrally made with the signal conductor (4).

Interconnection system

The invention relates to a connector comprising at least one shielded terminal, each shielded terminal being provided with at least one signal terminal, an earth contact surrounding the at least one signal terminal, at least one lug extending from the earth contact, which lug may be slid over the surface of another earth contact of another shielded terminal in order to provide electrical and mechanical contact with said other earth contact, the surface of the earth contact being able to electrically and mechanically contact at least one other lug extending from the other earth contact and the at least one signal terminal being able to electrically and mechanically contact another signal terminal of the other shielded terminal, which has substantially equal cross section dimensions as the shielded terminal.

Such a connector is known from US-A-3.958.851. The known connector comprises an inner conductor to carry a voltage signal and an outer earth conductor. The earth conductor comprises two parts: the first part is a plastic member provided with a metallic coating and directly surrounding the inner conductor, and the second part is a further shield member made from a punched conductive blank folded around the first part. The second, further shield member comprises a lug extending from the connector in the longitudinal direction, which lug may be slid over the surface of another earth terminal of another, identical shaped connector in order to make good electrical contact. However, a part of the second, further shield member has a rectangular shape, whereas the remaining part has a circular shape, thus a complex folding technique is needed during manufacturing. Furthermore, since the earth terminal comprises two parts the possibilities to miniaturise the known connector are limited: the connector is not suited for application in modern microelectronics in which connectors comprising several shielded terminals within one housing are used and in which cross section dimensions of each shielded terminal are no more than a few mm's. Moreover, because of the rather large dimensions of the known connector the signal loss in very high frequency applications is too large and it is very difficult to design the known connector for 50 ohms applications.

Other connectors comprising earth terminals having extending lugs are, for instance, known from FR-A-1.194.558, the additional French patent to this FR-A-1.194.558, and GB-A-626.696. These documents show several embodiments of connectors having extending earth lugs. However, all the embodiments shown comprise earth terminals comprising at least two parts and are not suitable for miniature applications. Moreover, they only show circular shaped connectors of rather large dimensions, which show too large signal losses in very high frequency applications.

A further connector having extending earth lugs is known from EP-A-0.414.495, in which coaxial terminals within a connector are described which have a conventional circular cross-section. Each connector may comprise more than one coaxial terminal, designed to be connected to a corresponding coaxial terminal, of the opposite type, of another connector. The signal conductor of the coaxial terminal terminates either in a male or in a female structure. The shape of the end of the earth contact of the terminal varies according to the terminal type: in a terminal whose signal conductor terminates in a male structure, the earth contact has four projecting lugs, while in the case of a terminal whose signal conductor terminates in a female structure, the earth contact has a closed cylindrical form which can be pushed into the four lugs of the earth contact of the first-mentioned terminal. Therefore, the known device requires the fabrication of various types of earth contacts, depending on the type of terminal for which the earth contact is intended. In this prior art connector, a design bent through an angle of 90° is shown of a coaxial terminal. The earth contact of this design is obtained from an earth contact blank, which is punched from a flat plate and which, via folding over various small plates and via clamping lugs, is to provide a substantially electrically enclosed envelope. The various folding steps make a design of this type vulnerable to incorrect alignment and thus to impedance mismatch. Moreover, in this known coaxial terminal the signal terminal is soldered to the signal conductor. Soldering electrical connections, however, is time-consuming and relatively expensive. The known design is suitable for impedances of approximately 75 Ω.

The object of the present invention is to provide a connector having at least one shielded terminal and which is suited for mini-

ature applications.

A further object of the present invention is to provide a connector showing low signal losses in very high frequency applications.

Moreover, it is an objective to provide a connector having a signal terminal which is connected to a signal conductor without using soldering techniques.

It is also an objective to provide a connector suitable to be used in 50 ohm applications.

Therefore, a connector of the type defined above is characterized in that the earth contact is made of only one electrically conducting piece and has a substantially symmetrical polygon cross section along its entire length.

Such a connector is easy to be manufactured by well known punch and folding techniques. Moreover, since only single piece earth terminals are used the shielded terminal(s) of the connector may be easily miniaturised. One earth terminal may, for instance, have a rectangular cross section having a width of only 1,8 mm and a height of also 1,8 mm. Moreover, such an earth terminal entirely shields the inner, signal conductor(s), so the signal losses are substantially reduced. Impedance matching to 50 ohm transmission lines may be easily accomplished.

In a preferred embodiment the earth contact comprises two indented small faces at the same end at which the two lugs are situated, which indented small faces are situated on those lateral faces of the earth contact, respectively, from which no lugs extend.

The signal terminal in the connector may be provided with at least one clamping lug on one end, which is to be folded around a signal conductor of an electrical cable to which the connector is to be fitted, in order to establish a firm electrically conductive contact. By applying such a clamping lug no soldering of the signal terminal to the signal conductor is needed, thereby saving manufacturing time and money.

When the connector is to be fixed directly to a printed circuit board the signal terminal may be connected to a signal conductor, which extends in the longitudinal direction within the shielded terminal and the signal terminal and the signal conductor

are preferably made from a single piece of blank.

The connector defined above may comprise several shielded terminals arranged in several columns and several rows. The connector may for instance comprise 4 columns and 3 rows of shielded terminals. When the shielded terminals are of a coaxial type such a connector may have a cross section dimension having a width of 12 mm and a height of 8,4 mm.

Each shielded terminal may be of a coaxial or twin-ax type.

Moreover, the connector may be mounted to a back panel and a common grounding of the earth contacts of the shielded terminals within the connector may be provided by an earth plate having openings through which said shielded terminals extend and spring fingers contacting earth pads of the back panel. By applying such an earth plate all earth contacts of the shielded terminals are connected to earth without using individual wires or the like which have to soldered to the earth contacts and to the earth pads on the back panel and which would enhance manufacturing time. Moreover, such an earth plate is easy to be manufactured and does not limit the required miniaturisation of the connectors. In some cases the earth plate may have a shielding effect against electro magnetic fields.

The invention further relates to a method to make an earth contact for a connector defined above, which comprises the following steps:

a. punching an earth contact blank from a flat plate of conductive material, the earth contact blank comprising at least one extending lug;

b. folding the earth contact blank over folding lines extending in the longitudinal direction of the earth contact blank in order to obtain an earth contact comprising a substantially symmetrical polygon cross section along its entire length.

In one embodiment of such a method the earth contact blank is provided with V-shaped notches which are arranged in such a way that after folding step b. to produce the earth contact, the earth contact is folded once more to provide a substantially electrically enclosed earth contact which has a predetermined angle.

The invention will be described in more detail below with reference to the accompanying drawings, which are intended to

illustrate the invention, rather than to limit it. The drawings show the following figures:

Figure 1 shows an overview of a coaxial interconnection system;

Figures 2a-c show various steps during the fabrication of terminals for signal conductors in coaxial cables;

Figures 3a-c and 4 show various steps during a fabrication method of terminals for signal conductors in a coaxial connector, the signal conductors being designed to be connected to a printed circuit board;

Figure 5 shows a side view of a coaxial terminal provided with an earth conductor;

Figures 6a and 6b show a loose component which is used to fabricate the earth conductor for the coaxial terminal according to Figure 5;

Figures 7 and 8 show alternative components for fabricating earth connections in coaxial connectors;

Figure 9 shows a spacer between an earth contact and a signal conductor;

Figure 10 shows a coaxial connection part according to Figure 9 in a housing.

Figure 11 shows a connection system based on twin-ax type connection elements;

Figures 12a and 12b show an earth plate to be used to ground earth contacts of all shielded terminals within one connector;

Figure 13 shows, partly in a cross section view and partly in an exploded view, a connector fixed to a back panel, in which connector the earth plate of figures 12a and 12b is used;

Figure 14 shows an alternative way of mounting a connector according to the invention to a printed circuit board.

In Figure 1, various options are shown for a coaxial interconnection system. On a printed circuit board 1 there is a coaxial terminal 2, which is arranged so as to be bent through an angle of 90°. In Figure 1, within a housing 11, indicated by a dot-and-dash line, two coaxial connections are shown in a side view. In the housing 11 there is, however, enough room for a third coaxial terminal as can be seen from the figure. Overall, the housing 11 may, for example, contain twelve coaxial terminals, arranged in

four columns and three rows. Such a housing 11 may have a width of only 12 mm and a height of only 8.4 mm.

Each coaxial terminal comprises at least an earth conductor 3 and a signal conductor 4, as shown in Figure 1 for a cross-section of the coaxial terminal 2. Further illustrated in this cross-section is a signal terminal 8 which forms a whole with the signal conductor 4, as will be described hereinafter in more detail. Between the earth contact 3 and the signal terminal 8 there is an insulating wall 6. Between the signal conductor 4 and the earth contact 3 there are insulating means, for example in the form of one or more insulating blocks 5. The earth contact 3 is connected, so as to be electrically conductive, with earth lugs 7 which extend beyond the insulating wall 6. Said earth lugs 7 can be brought into electrically conductive contact with the earth contact 21 of a coaxial terminal 18, as will be described later in more detail. The signal terminal 8 can be brought into conductive contact with a signal conductor 19 of the coaxial terminal 18.

The coaxial terminal which is located within and at the bottom of the housing 11 is seen in side view. The figure therefore shows the lateral face of the earth contact 3, which is folded rectangularly about the signal conductor 4, as will later become clearer with reference to Figures 5, 6 and 6b. On the visible face of the earth contact 3, there is an indented small face 10, over which an earth lug (not shown) of a coaxial connection point 13 can be slipped. The earth contact 3 is bent through an angle of approximately 90°, and as a result the coaxial terminal extends substantially parallel to the surface of the printed circuit board 1. The earth contact 3, by means of pins 9, projects through the surface of the printed circuit board 1. If required, a printed earth conductor on the printed circuit board 1 can be soldered to the pins 9.

The housing 11, together with part of the printed circuit board 1, can be pushed into a housing 25, which housing 25 is indicated by a dot-and-dashed line and within which the coaxial terminals 13, 18 shown are located. The coaxial terminals 13, 18 are fastened to a second printed circuit board 12. In this case, the coaxial terminal 18 projects through the second printed circuit board 12, while the coaxial terminal 13 is mainly to one side of

the second printed circuit board 12. The earth contact 16 of the coaxial terminal 13 has pins 17, which project through the second printed circuit board 12, while the signal conductor 14 of the coaxial terminal 13 also projects through the second printed circuit board 12. The coaxial terminal 13 thus terminates, as it were, on the second printed circuit board 12. The signal conductor 14 is electrically connected (in a manner not shown) to printed conductors on the second printed circuit board 12, on which there may be electronic components. The earth pins 17 are connected to a printed earth conductor (not shown) on the second printed circuit board 12.

The coaxial terminal 18, in its entirety, passes through the second printed circuit board 12, in such a way that the signal conductor 19 does not make electrical contact with printed conductors on the second printed circuit board 12.

Figure 1 shows yet another coaxial terminal 22 in side view. This further coaxial terminal 22 extends substantially entirely to the right-hand side of the printed circuit board 12, in order to be able to make electrical contact with a coaxial terminal 28, which forms part of a connector of a coaxial cable (not shown). In Figure 1, the lateral face 23 of this further coaxial terminal 22 is shown, on which face 23 there is a lug 24. The lateral face 23 is made of an electrically conductive material and serves as the earth contact, while the earth lug 24 has the same shape and function as the earlier-mentioned earth lug 7, although earth lug 24 in this case corresponds to a top view of the earth lug 7 shown in side view. The earth lug 24 can be brought into electrically conductive contact with an indented small face 30 of the earth contact 29 of the coaxial connection point 28. Rotated through an angle of 90° with respect to the earth lug 24, the coaxial terminal 28 comprises two earth lugs 31, which can be brought into electrically conductive contact with indented small faces (not shown) situated on the top face and bottom face of the earth contact 23. Below the coaxial terminal 28, a cross-section is shown in Figure 1 of a coaxial terminal 27 of the same (not shown) coaxial cable as that of which the coaxial terminal 28 forms part. The design of the coaxial terminal 27 is identical to that of coaxial terminal 28. A signal terminal 108 within the coaxial terminal 27 differs somewhat from the signal terminal 8 within the coaxial terminal 2: a signal con-

ductor (not shown) of the coaxial cable, with which the coaxial terminal 27 is associated, can be connected, with the aid of clamping lugs 46, to the signal terminal 108 in an electrically conductive manner, as will later be further explained with reference to Figures 2a-c.

Within the housing 26 of the connector, two coaxial terminals 27, 28 are shown above one another. As can be seen from Figure 1, there is enough room within the housing 26 for a third coaxial terminal below the coaxial terminal 27. The housing 26 of the connector extends, in a direction perpendicular to the plane of Figure 1, to such an extent that the housing 26 of the connector provides room for four columns of three rows of coaxial terminals. The housing 26 of the connector therefore has room for a total of twelve coaxial terminals. Obviously, the housing 26 of the connector can also be of different dimensions, and as a result different numbers of coaxial terminals can be accommodated.

In the upper part of Figure 1, a part of the coaxial interconnection system is shown which, in side view, always comprises four coaxial terminals located above one another. To the top and to the right of the figure, a housing 36, indicated by a dot-and-dash line, of a connector of a coaxial cable is shown, within which there are four coaxial terminals of which one is indicated by 39. The coaxial terminal 39 is shown in side view. This side view shows an earth contact 38 and an earth lug 37 connected thereto in an electrically conductive manner. The earth lug 37 can be pushed over an indented small face 32 of the earth contact 34 of a coaxial terminal 41 on the second printed circuit board 12. The earth contact 34 again has two earth lugs 35, which are rotated through an angle of 90° with respect to the earth lug 37. The earth lugs 35 again can interact with indented small faces (not shown) on the earth contact 38 of the coaxial terminal 39. Each earth contact of each coaxial terminal thus preferably comprises two earth lugs which can interact with two indented small faces on an earth contact of another coaxial terminal interacting therewith. This other coaxial terminal in its turn again comprises two earth lugs, which, however, are rotated through an angle of 90° with respect to the first-mentioned two earth lugs. As can be seen from Figure 1, all types of coaxial terminals, i.e. both those of which the signal

conductor 4 is connected to a signal terminal 8 with a female shape, and those with a signal conductor 19 with a male shape, have the same design for the earth contact and the two earth lugs. In that sense, the earth of each coaxial terminal is hermaphrodite. It is to be noted that it is preferable for each earth contact (for example 3) to be designed to have two lugs (for example 7), but that in principle it is also possible to have earth contacts with one lug or with more than two lugs, even though the design becomes more complex if there are more than two lugs.

The coaxial interconnection system which is shown at the top of Figure 1 illustrates that the housing 36 of a connector of a coaxial cable, having, for example, a total of twelve coaxial cables to one side of the printed circuit board 12, can be coupled with an interconnector, which then likewise comprises twelve coaxial terminals and which is situated, at the top of Figure 1, on the printed circuit board 12, and whose coaxial terminals all project through the printed circuit board. All these coaxial terminals projecting through the printed circuit board 12 in Figure 1 have the same design, namely a signal conductor 33 of male shape, which signal conductor 33 can be coupled with a female signal terminal (not shown) of an interacting coaxial terminal, for example 39.

In the same way as the housing 36 of a connector of a coaxial cable can interact with the housing 44 on the right-hand side of the printed circuit board 12, a housing 40 of another coaxial cable is able to interact with a housing 43 provided with coaxial terminals on the left-hand side of the printed circuit board 12. It is thus possible to use groups of coaxial terminals, which project through the printed circuit board 12, as an interconnection system for two coaxial cables whose signal terminals are of the same type, so that these two coaxial cables cannot be coupled directly to one another. In Figure 1, housings 43 and 44, respectively, are shown on the left-hand and right-hand side, respectively, of the printed circuit board 12, which housings are able to interact with the housings 40 and 36, respectively, of different coaxial cables. Housings 43, 44 of this type make it considerably simpler to connect the connectors of coaxial cables to groups of coaxial terminals on the printed circuit board 12, but they are not strictly necessary.

Figure 1 therefore gives an overall view of various possibilities of the present coaxial interconnection system. Thus, connectors of coaxial terminals on two different printed circuit boards 1, 12 can be connected to one another, coaxial terminals, if required, may project through a printed circuit board, coaxial terminals on a printed circuit board can be shaped and grouped in such a way that they can serve as interconnection system for two coaxial cables, and coaxial terminals (for example 13, 22) can terminate on a printed circuit board.

Owing to the special design of the coaxial terminals, these may be of particularly small dimensions. A fabrication method for said coaxial terminals will now be explained with reference to the following figures. Figures 2a-c show how a signal terminal 108 can be fabricated which is especially designed for coaxial cables. The process starts with a flat plate of suitable material, from which several blanks, which in Figure 2a are still flat, for terminals 108 are punched out. The various flat blanks for the terminals 108 are still connected to one another via webs 47, 48. Each signal terminal 108 comprises two signal conductor lugs 45 and at least one clamping lug 46. The clamping lugs 46 extend laterally from a thin web 49, which connects the wider webs 47 and 48 to one another. This is shown in Figure 2a.

First of all, the narrower webs 49 are cut through near the clamping lugs 46. The signal conductor lugs 45 are then bent through an angle of, substantially, 90° with respect to a supporting surface 50 connected to the wider web 47. As can be seen from Figure 2b, the signal conductor lugs 45 at their ends have also been bent towards one another, being pre-tensioned as a result with respect to a conductor pin of a male coaxial terminal, with which said signal conductor lugs 45 are to interact. On the other side of the wider web 47, part of the narrower web 49 then still extends from which, as already mentioned, one or two clamping lugs 46 project. The clamping lugs 46 are folded over with respect to the narrower web 49. If, for example, there are two clamping lugs 46, these can be bent towards one another about a line 51 indicated by a dot-and dashed line, as can be clearly seen in Figure 2c, said figure showing a perspective view of several signal terminals 108 placed next to one another. The signal terminals 108, which are

still connected to one another, are then separated by cutting through the wider web 47. In this way it is possible to obtain signal terminals 108 of very small dimensions.

The signal terminal 108 is then connected to a signal conductor of a coaxial cable (not shown) by firmly clamping together the clamping lugs 46, after the signal conductor in question has been placed between them. The signal terminal 108 as a whole can then be placed in an insulating casing 106 (Figure 1). Between the signal terminal 108 and the insulating walls 106 there may be a compression joint, for example by projections 52 being formed on the wider web 47 between the supporting surface 50 and the thinner web 49 (see Figures 2b, 2c), which projections provide a friction joint with the insulating walls 106.

Figures 3a-c show how a signal terminal 8 and a signal conductor 4 can be punched from one whole and thus can be adapted for use in a coaxial connector placed on a printed circuit board 1. Figure 3a shows a blank, still in flat form, as can be punched from a flat plate. On one end of the blank there are two signal conductor lugs 145, which are connected to one another via a supporting surface 150. The supporting surface is connected to a web 147, which connects adjacent signal terminals 8 to one another. The signal terminal 8 has been punched as one whole together with a signal conductor strip 4 which, via a second web 148 and a third web 149, is connected to an adjacent signal conductor strip 4. The signal conductor strip 4 is cut through near the third web 149. The signal conductor strip 4 is separated from its adjacent signal conductor strip (or signal conductor strips) by cutting the second web 148 between two adjacent signal conductor strips 4. The flat signal conductor strip 4 is then rotated through an angle of 90° about the junction point between the signal conductor strip 4 and the signal terminal 8, so that the entire signal conductor strip 4 ends up in a position perpendicular to the plane of the drawing of Figure 3a. Finally, the two signal lugs 145 are each bent through an angle of 90° with respect to the supporting surface 150, so that the view of Figure 3b is obtained. In Figure 3b, a projection 152 has been drawn in addition, which provides a compression joint with an insulating casing 6, in which the signal terminal 8 is placed. Figure 3c shows a side view of the design thus obtained.

Neither the design of a signal terminal 148 according to Figures 2a-c, nor of a signal terminal 8 according to Figures 3a-c any longer require a soldered connection between the signal terminal 8, 108 and a signal conductor 4.

Figure 4 shows a signal terminal 8, obtained according to the steps of Figures 3a-c, having a signal conductor 4 in an insulating casing 6. The insulating casing 6 encloses the signal terminal 8 in its entirety and has a compression joint with the projection 152.

Figure 5 shows the assembly according to Figure 4, which has been pushed into an earth contact 3. The earth contact 3 is provided with earth lugs 7. Figure 6b shows a perspective view of the earth contact 3 provided with the earth lugs 7. The earth contact 3, like the signal terminal 8, is fabricated from a flat plate of suitable conductive material. This is shown in Figures 6a and 6b. Figure 6a shows the earth contact 3, after it has been punched from a flat conductive plate and before it has been folded into the correct shape. The earth contact 3 according to Figure 6a then preferably has two projecting earth lugs 7, two indented small surfaces 10 and V-shaped notches 53, 53'. Near the V-shaped opening 53, 53', projecting flaps 3e, 3f, and 3g, respectively, are attached to the strips 3a, 3c and 3d, respectively.

On the earth contact 3, while it is still flat, three folding lines 54, 55, 56 are arranged, which divide the earth contact 3 into four parts 3a, 3b, 3c, 3d. In the situation according to Figure 6a, there are two indented small faces 10 on the strips 3a and 3c, respectively, while the two earth lugs 7 extend from the strips 3b and 3d, respectively. The earth contact according to Figure 6b is now produced from the flat earth contact 3 according to Figure 6a by folding the flat earth contact according to Figure 6a along all the folding lines 54, 55, 56 through an angle of 90°. The strip 3b is then situated, for example, on the top of a rectangular earth contact 3 (Figure 6b), while the strip 3c is then situated laterally. Strip 3a is then situated at the back of the earth contact 3 according to Figure 6b, and strip 3d is at the bottom. In this manner, the two earth lugs 7 of the folded earth contact 3 are located opposite one another. Similarly, the two indented small faces 10 on the strips 3a, 3c are now located opposite one another. Furthermore, the earth lugs 7 are always positioned so as to be

twisted by an angle of 90° with respect to the indented small faces 10. The two earth lugs 7 are preferably slightly bent towards one another, so that they have a certain pre-tension. It can easily be seen that the earth contact 3, of a design as shown in Figure 6b, can interact with an identical earth contact 3 which, however, has been rotated through 90°, that is to say in which, for example, strip 3c is at the top. In that case, the earth lugs 7 and the indented small faces 10 can interact effectively with similar earth lugs and indented small faces of the other earth contact which has been rotated through 90°. An earth contact 3 of this type can be placed over a signal conductor 4 which has either a female or a male terminal. Consequently, as stated earlier, the earth contact 3 can be called hermaphrodite.

Figure 7 shows a punched-out earth contact 34, still flat, which can be used for a coaxial terminal which, as a whole, projects transversely through a printed circuit board 12 (compare Figure 1). The earth contact 34 comprises three folding lines 57, 58, 59, which divide the earth contact 34 into four strips 34a, 34b, 34c, 34d. A total of four earth lugs 35 project from the conductor strips 34b, 34d. On the two other strips 34a, 34c there are, in total, four indented small faces 32, which can interact with earth lugs of other earth contacts. By folding the flat design of the earth contact 34 of Figure 7 along the folding lines 57, 58, 59 through an angle of 90° in each case, a rectangular earth contact 34 is produced in analogy to the design according to Figure 6b. A side view of such a rectangular construction of the earth contact 34 can be seen in Figure 1. Within such an earth contact 34, there is then a signal conductor 33 which is separated from the earth contact 34 with the aid of suitable insulating means (for example indicated as 20 in the case of the coaxial terminal 18 in Figure 1).

Figure 8 shows a flat earth contact 29 such as can be used for a coaxial terminal 28 (Figure 1). The earth contact 29 is provided with two earth lugs 31 and two indented small faces 30 which are positioned on alternate strips of the earth contact 29. Four adjacent strips 29a, 29b, 29c, 29d are provided, which are separated from one another by means of folding lines 60, 61, 62. The flat design according to Figure 8 can again give a rectangular

earth contact 29 by folding the design along the folding lines 60, 61, 62 through an angle of 90° in each case. A side view of such a rectangular earth contact 29 can be seen in Figure 1.

Figure 9 shows the next step after the construction according to Figure 5. After the design according to Figure 4 has been pushed into an earth contact 3 as shown in Figure 6b, a spacer 63 is pushed into the earth contact 3, which spacer 63 prevents any electrically conductive contact between the signal conductor 4 and the earth contact 3. The spacer 63 may have any suitable required shape.

Once the design according to Figure 9 has been achieved, corresponding to a complete coaxial terminal 2 (Figure 1), a housing 11 (Figure 1) can be provided with coaxial terminals 2. This is illustrated in Figure 10. Figure 10 shows a coaxial terminal 2 which has been pushed into an opening 65 of the housing 11. On the left-hand side of the figure, part of the opening 65 is still free for receiving a coaxial terminal provided with a male signal conductor, as is indicated in Figure 1, for example, by 18. On the right-hand side of Figure 10, a part of the coaxial terminal 2 projects from the housing 11, specifically with a part of the earth contact 3 within which the signal conductor 4 is situated. The earth contact 3, which projects from the housing 11, initially comprises at least the V-shaped opening 53. The function of the V-shaped opening is explained in more detail in Figure 10. Folding up the V shape 53 produces a design, bent through 90°, of the earth contact 3. Folding up the V-shaped notch 53 will also lead to the signal conductor 4 being bent through an angle of 90°, which can easily be achieved because the plane of the signal conductor 4 is perpendicular to the plane of the drawing according to Figure 10. The earth contact 3 can be provided with pins 9 which can be plugged into holes in the printed circuit board 1, which are designed for this purpose. The same applies to the projecting part of the signal conductor 4. The pins 9, at the start of the fabrication process of the earth contact 3, can easily be formed at the same time by adjusting the punch, so that they form one whole with the earth contact 3. Figure 10 illustrates that the flap 3f seals off the folded-up V-shaped opening 53 in order to further reduce electromagnetic interference. The flaps 3e and 3g (not visible)

have the same function as flap 3f. In this way it is possible to provide a connector on a printed circuit board, of which the housing 11 is at an angle of 90° with respect to the plane of the printed circuit board. Obviously the housing 11 may, if required, also be at an angle other than 90° with respect to the printed circuit board 1, namely by setting the V shape 53, 53' at a different predetermined angle.

It will be clear from the above that signal terminals 108 having a female structure can be punched and formed as a whole, and without soldering can be connected to signal conductors of coaxial cables in a firm, electrically conductive manner. It is further possible to provide signal terminals 8 which form one whole with a signal conductor 4. Likewise, an earth contact 3 with a hermaphrodite structure is provided, which is formed from one whole by means of punching and folding. In this way it is possible to obtain very small and very reliable coaxial terminals. The internal diameter of each coaxial terminal may, for example, be 1.6 mm, the external diameter being at most 2 mm. By choosing the dimensions correctly, an impedance of 50 ohm for analog signals can be readily provided. Within a housing 11 of a connector having dimensions of approximately 8.4 x 11.95 mm in cross-section, twelve coaxial terminals can easily be arranged, specifically in four columns of three rows.

It will be obvious to those skilled in the art that various variations are possible without going beyond the scope of the invention. Thus, a rectangular cross-section of the earth contact is not strictly necessary. The earth contact may also comprise a different even number of flat lateral faces, in which the lateral faces alternately do and do not comprise earth lugs. Fewer earth lugs are also possible, as long as the orientation is such that a coaxial terminal whose signal conductor terminates in a female structure can interact with another coaxial terminal whose signal conductor terminates in a male structure.

Moreover, the use of clamping lugs 46 in a signal terminal 108 is not restricted to signal terminals of a female design. Even in the case of male signal terminals, clamping lugs 46 of this type can be used advantageously.

Furthermore, the invention is not restricted to shielded connections having only one signal conductor within an earth con-

tact. Figure 11 shows a further embodiment of the present invention which relates to a twin-ax system, i.e. shielded connections provided with two signal conductors within the shielding member, which signal conductors may carry a differential mode signal. Three twin-ax connection elements 201, 202, 203 are shown. The twin-ax connection elements 201, respectively 203 have earth contacts 204, respectively 212 provided with extending lugs 205, respectively 209. Twin-ax connection element 201 may be fixed to a printed circuit board 1, schematically depicted by dotted lines, by means of pins 206, while twin-ax connection element 203 may be fixed to a printed circuit board 200 by pins 210. These pins 206, 210 may be soldered or press-fit.

Both twin-ax connection element 201 and 203 have two openings 208 each accommodating a female type signal terminal (shown in figures 3a, 3b, 3c). The openings 208 are each designed to receive a male type signal terminal 207 of a mating twin-ax connection element 202. The latter twin-ax connection element 202 can also be provided with extending lugs 199 which may be slid along the surface of the earth contacts of the mating twin-ax connection elements 201, respectively 203 when connecting the twin-ax connection element 202 to the twin-ax connection elements 201, respectively 203. Then, the extending lugs 205, respectively 209 are slid along the surface of the earth contact 211 of the twin-ax connection element 202.

The twin-ax connection element 202 may pass through a back-panel 12, as shown in figure 11.

In a preferred embodiment several twin-ax connections elements are grouped together within a single housing 218 (figure 13) and arranged, for instance, in three columns and four rows. Each earth contact 211 of each twin-ax connection element 202 should preferably be connected to common earth pads 217 on the back-panel 12 through which each twin-ax connection element 202 extends. In order to avoid many separate earth connections and soldering wires or the like to the earth pads 217 and to the earth contact 211, preferably, an earth plate 213 is used which is shown in figures 12a and 12b on an enlarged scale.

Figure 12a shows a side view of the earth plate 213 which is made of a resilient conducting material. Figure 12b shows a front

view of the earth plate 213. Two edges of the earth plate 213 are curved in order to provide spring fingers 216. The earth plate 213 is provided with holes 214 each designed to receive a twin-ax connection element 202. In order to establish adequate electrical contact between each earth contact 211 of each twin-ax connection element 202 and the earth plate 213, preferably, resilient lugs 215 are provided along the edges of the holes 214 (figure 12a). These resilient lugs 215 may be made integrally with the earth plate 213 by well known manufacturing methods like punching and folding.

The earth plate 213 may have a width of 11,95 mm and a height of 14,90 mm.

During assembling the back-panel 12 with each of the twin-ax connection elements 202 the earth plate 213 is slid over the twin-ax connection elements 202 as indicated by arrows 198 in figure 13. Each of the twin-ax connection elements passes through a hole 214 and the spring fingers 216 are pushed against the earth pads 217 in order to establish good electrical contact. Then a housing 219 provided with openings 196 is fitted to the back-panel 12 in such a way (indicated by arrows 197) that each twin-ax connection element 202 extends through an opening 196 and the housing 219 presses the earth plate 213 against the earth pads 217. Therefore, no additional soldering of the earth plate 213 to the earth pads 217 is needed. The housing 219 is designed to receive a mating housing (not shown) provided with female type signal conductors to establish electrical contact to the male type signal conductors 207.

Although in figure 13 the earth plate 213 is shown to be slid over the twin-ax connection elements 202 provided with male type signal conductors 207, of course, the signal conductors may be female type. Moreover, as may be clear to any person skilled in the art the earth plate 213 may also be applied to coaxial connecting elements 13, 18, 22 grouped together within a single housing 25 (figure 1).

Figure 14 shows an alternative way to mount a housing 222 provided with several signal terminals 230, 231, 232, 233 to a printed circuit board 220. This way of mounting is called "straddle mount". In figure 14 housing 222 is mounted to the printed circuit board in such a way that four signal conductors 230, 231, 232, 233 extend in a direction parallel to the surface of the printed cir-

cuit board 220. Moreover, two 230, 231 of these signal terminals are at one side of the surface of the printed circuit board 220 and via their signal conductors 235, 236 they are connected to it by contact lugs 228 and 225 respectively. The other two 232, 233 of these signal terminals are at the other side of the surface of the printed circuit board 220 and via signal conductors 237, 238 and contact lugs 226 and 227 respectively they are connected to the other side of the printed circuit board 220.

Of course, the signal terminals 230, 231, 233, 234 may be part of a coaxial type of connection element or a twin-ax type of connection element.

All signal terminals 230, 231, 232, 233 are enclosed by an appropriate earth contact one of which is indicated with the reference sign 229.

Although in figure 14 the signal terminals 230, 231, 232, 233 are shown to be female type it may be clear to persons skilled in the art that the straddle mounting way shown may also be used when the signal terminals are male type.

Moreover, although in all embodiments shown the signal terminals are shown to be either female or male type all signal terminals may have a hermaphroditic structure, as is known to persons skilled in the art.

Claims

1. Connector comprising at least one shielded terminal (2), each shielded terminal being provided with at least one signal terminal (8), an earth contact (3) surrounding the at least one signal terminal, at least one lug (7) extending from the earth contact, which lug (7) may be slid over the surface of another earth contact (21) of another shielded terminal (18) in order to provide electrical and mechanical contact with said other earth contact (21), the surface of the earth contact (3) being able to electrically and mechanically contact at least one other lug extending from the other earth contact (21) and the at least one signal terminal (8) being able to electrically and mechanically contact another signal terminal (19) of the other shielded terminal (18), which has substantially equal cross section dimensions as the shielded terminal (2) characterized in that the earth contact (3) is made of only one electrically conducting piece and has a substantially symmetrical polygon cross section along its entire length.

2. Connector to Claim 1, characterised in that the earth contact (3) is provided with two lugs (7) on at least one end, which lugs (7) are situated substantially opposite one another.

3. Connector according to Claim 2, characterised in that the earth contact (3) comprises two indented small faces at the same side end at which the two lugs (7) are situated, which indented small faces are situated on those lateral faces of the earth contact (3), respectively, from which no lugs (7) extend.

4. Connector according to Claims 2 or 3, characterised in that the earth contact (34) is provided with two outward-extending lugs (35) at both sides and with two indented small faces (32) at both sides.

5. Connector according to any of the preceding Claims in which the at least one signal terminal (108) on one end is provided

with at least one clamping lug (46) to be folded around a signal conductor of an electrical cable to which the connector is to be fitted, in order to establish a firm electrically conductive contact.

6. Connector according to any of the Claims 1-4 in which the signal terminal (8) is connected to a signal conductor (4), which extends in the longitudinal direction within the shielded terminal (2) and the signal terminal (8) and the signal conductor (4) being integrally made from a single piece of blank.

7. Connector according to Claim 5 or 6, characterised in that the signal terminal (8, 108) comprises two signal conductor lugs (45, 145), which are folded over with respect to a supporting surface (50, 150) and which face each other.

8. Connector according to Claim 7, characterised in that the signal conductor lugs (45, 145) are bent somewhat towards one another, in order to provide them with a mechanical pre-tension.

9. Connector according to any of the preceding Claims characterized in that the connector comprises several shielded terminals arranged in several columns and several rows.

10. Connector according to any of the preceding Claims characterized in that each shielded terminal is of a coaxial type.

11. Connector according to any of the Claims 1 to 9 characterized in that each shielded terminal is of a twin-ax type.

12. Connector according to any of the preceding Claims characterized in that the connector is mounted to a back panel (12) and in that common grounding of the earth contacts of the shielded terminals within the connector is provided by an earth plate (213) having openings (214) through which said shielded terminals extend and spring fingers (216) contacting earth pads (217) of the back panel (12).

13. Method to make an earth contact (3, 21, 29, 34, 204, 211, 212) for a connector according to any of the preceding Claims, characterised by the following steps:

a. punching an earth contact blank from a flat plate of conductive material, the earth contact blank comprising at least one extending lug (7, 31, 35);

b. folding the earth contact blank over folding lines extending in the longitudinal direction of the earth contact blank in order to obtain an earth contact comprising a substantially symmetrical polygon cross section along its entire length.

14. Method to make an earth contact (3, 204, 212) for a connector according to Claim 13, characterized in that the earth contact blank (3, 204, 212) is provided with V-shaped notches (53, 53') which are arranged in such a way that after folding step b. to produce the earth contact, the earth contact is folded once more to provide a substantially electrically enclosed earth contact which has a predetermined angle.

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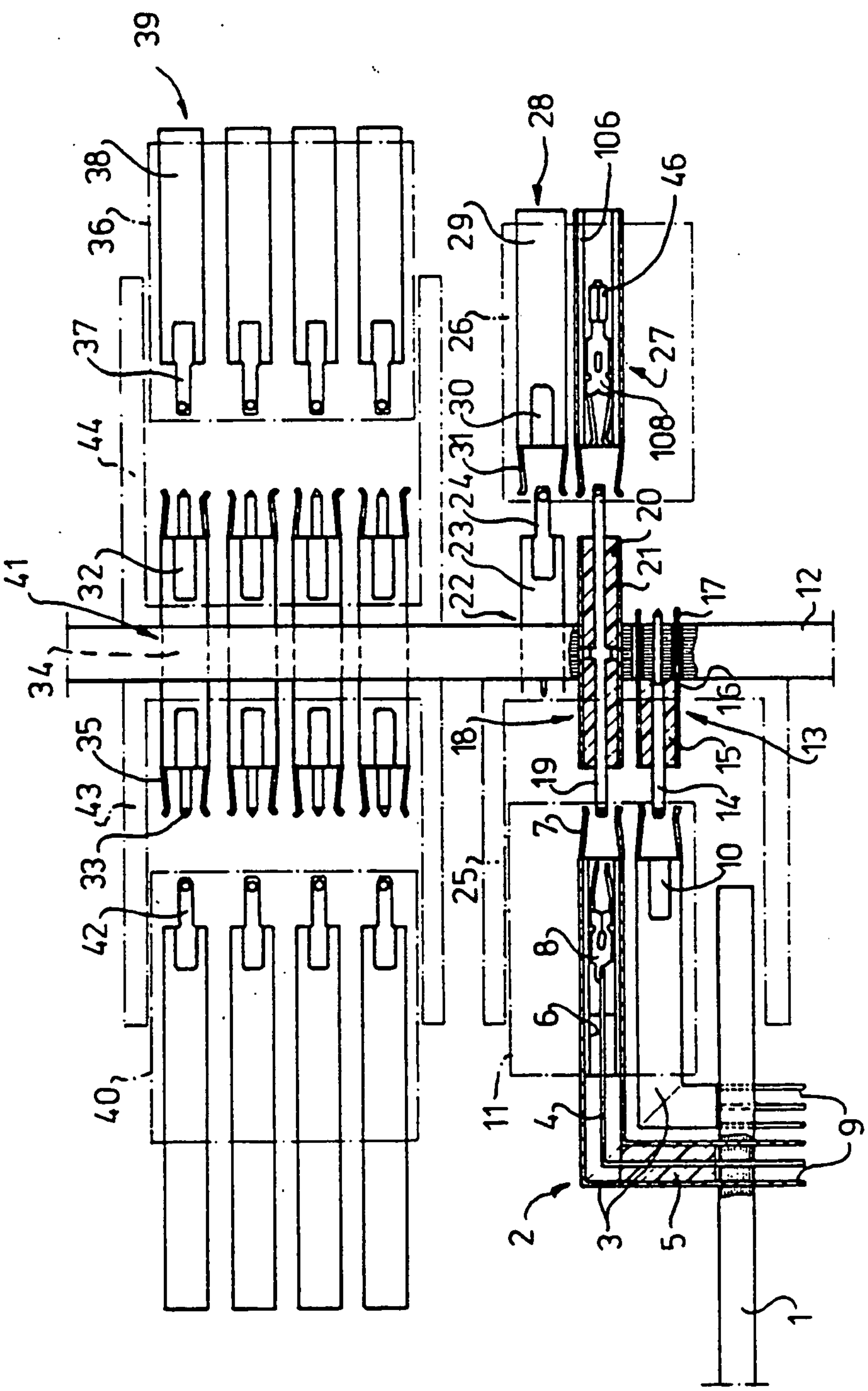
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Fig-1

Fig-2a

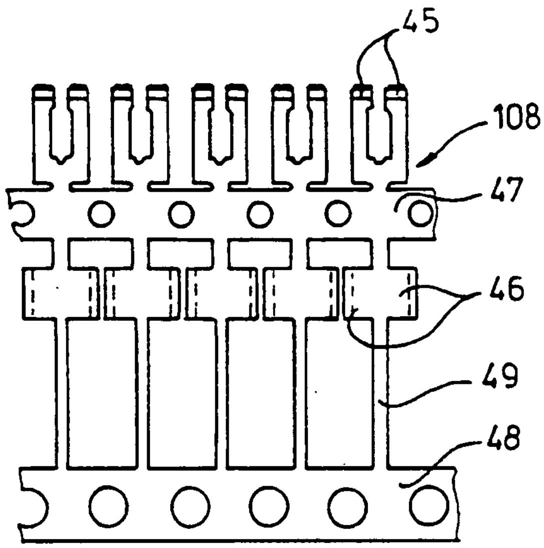


Fig-2b

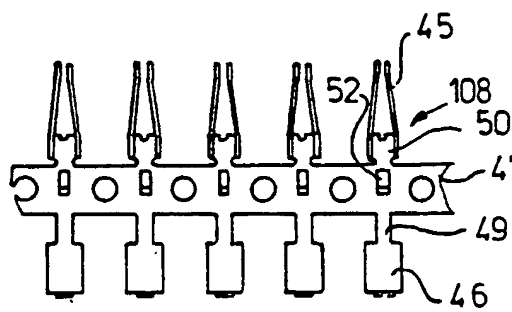


Fig-2c

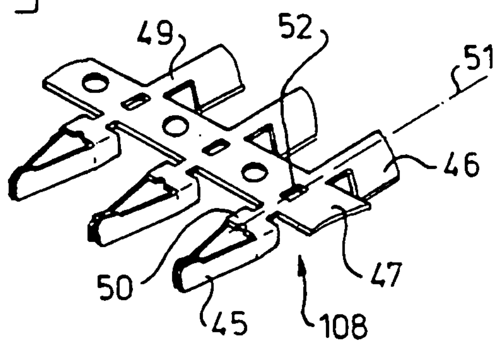


Fig-3a

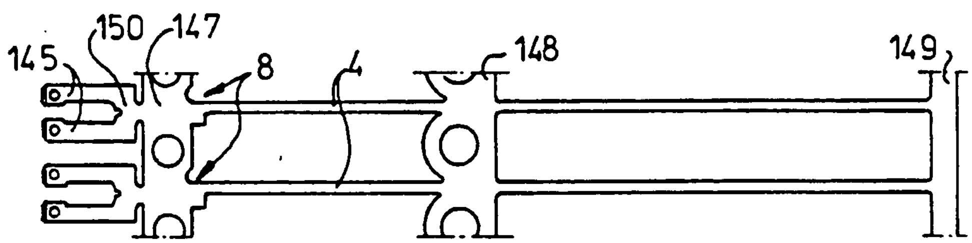


Fig-3b

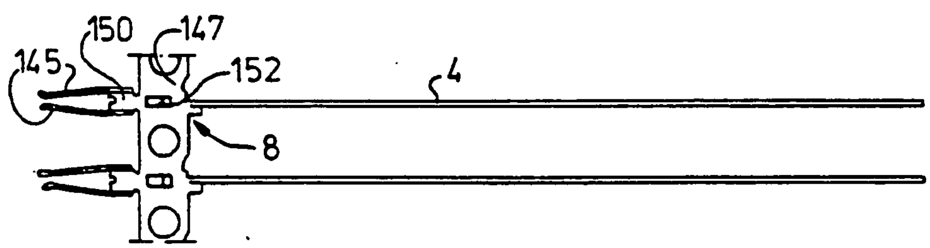
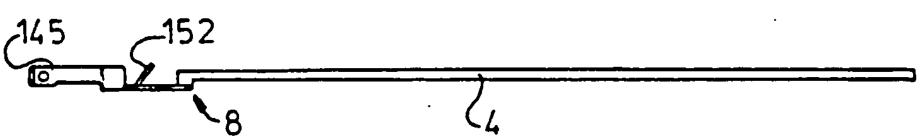


Fig-3c



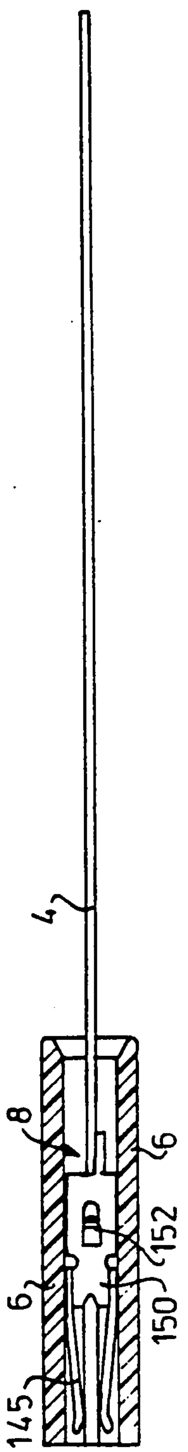


Fig-4

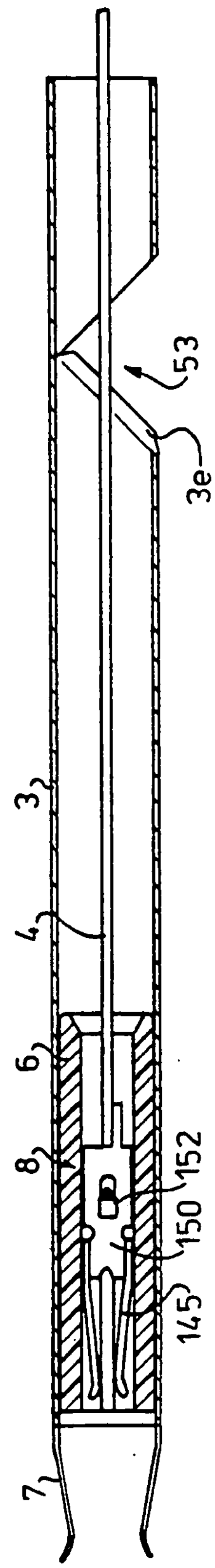


Fig-5

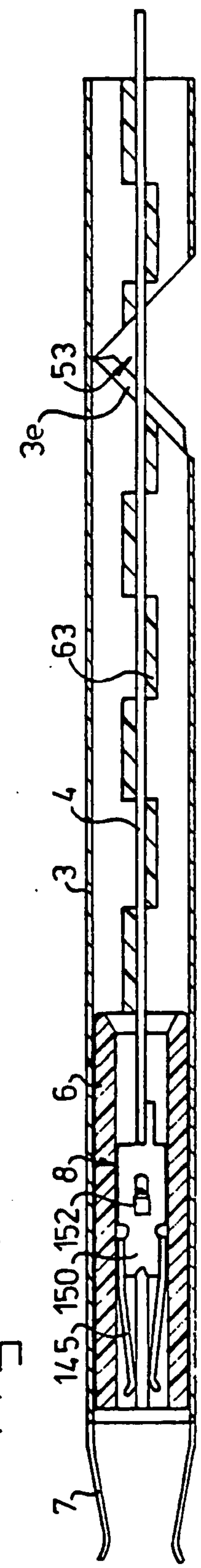


Fig-9

Fig-6a

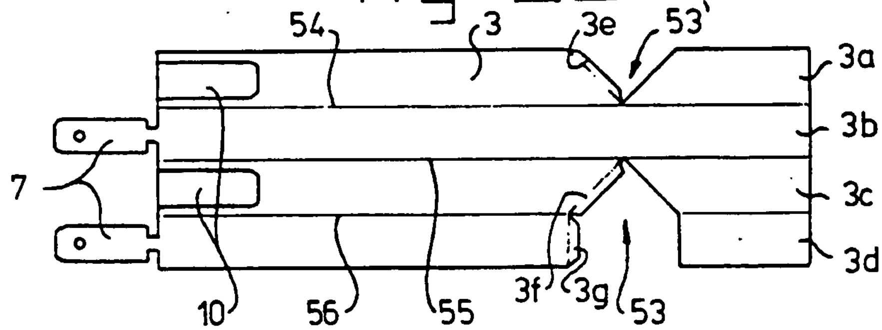


Fig-6b

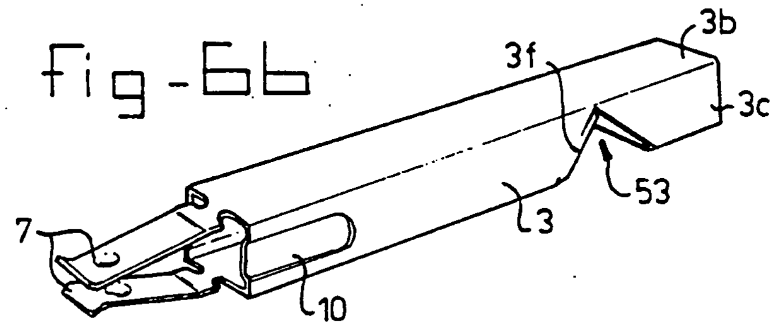


Fig-7

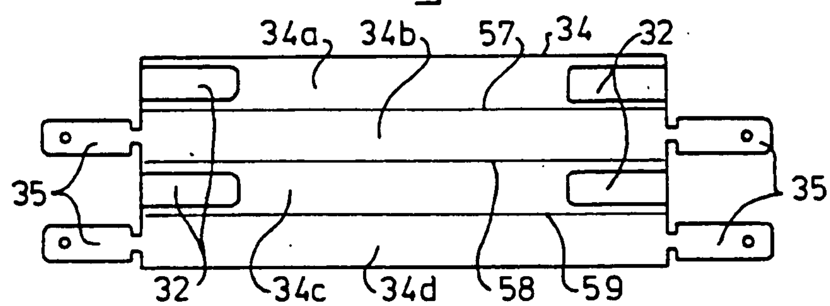
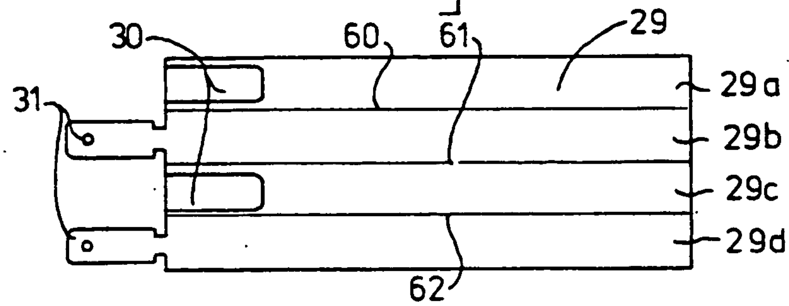


Fig-8



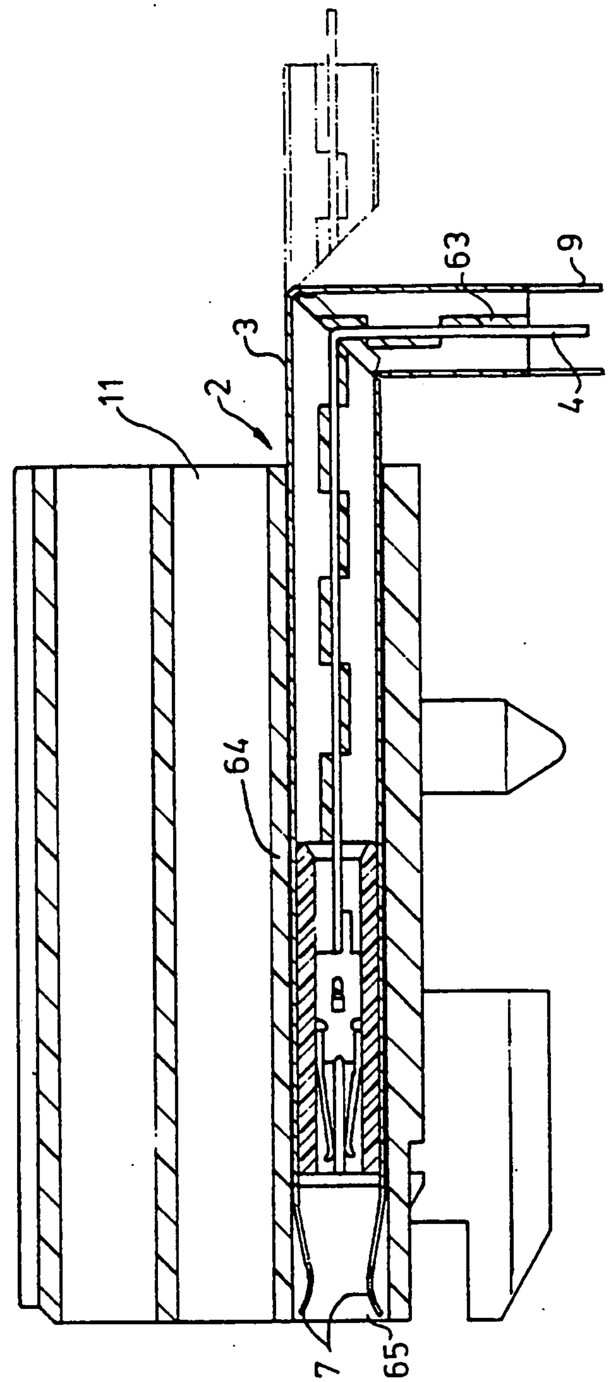


Fig-10

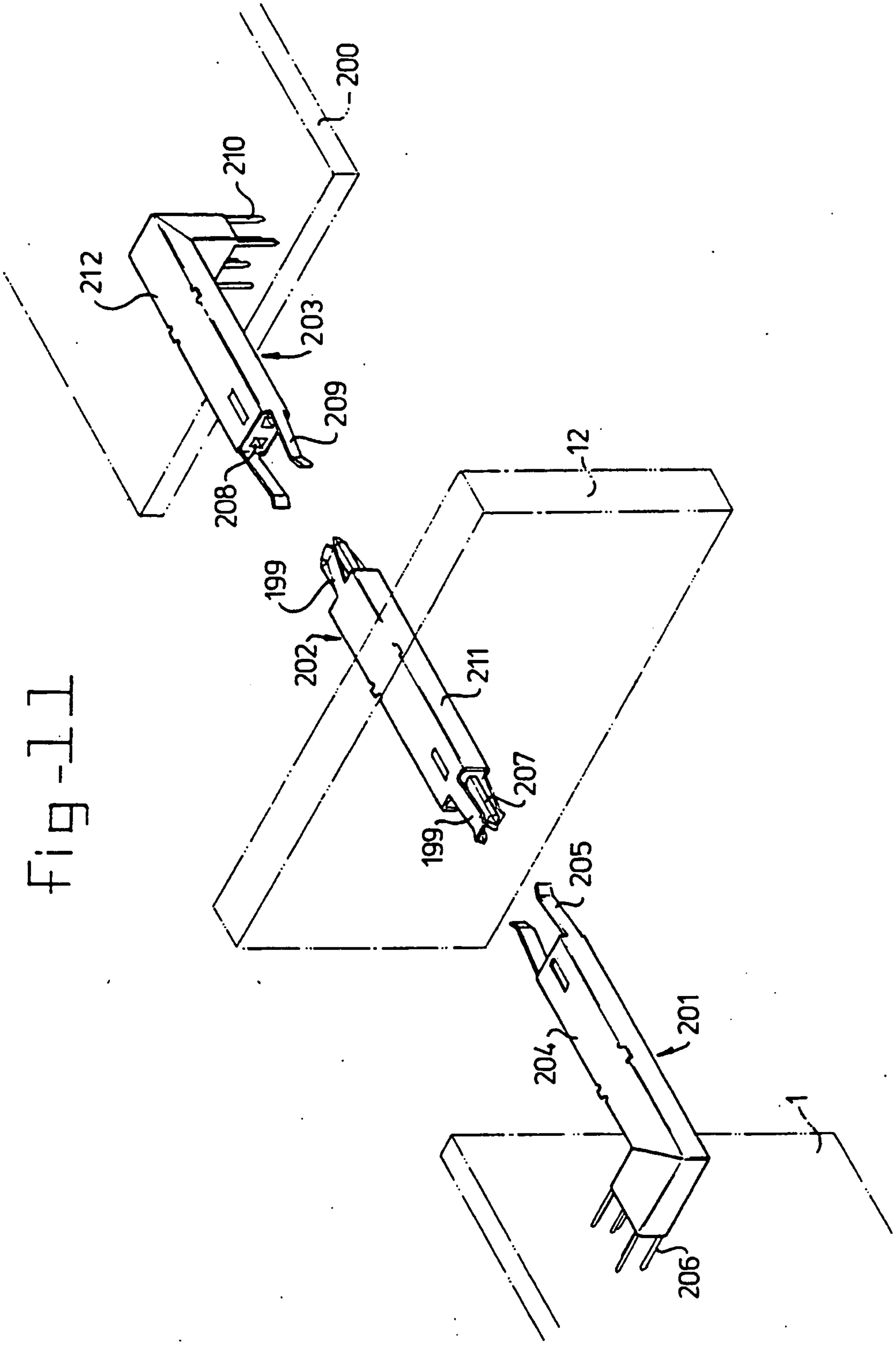


Fig-11

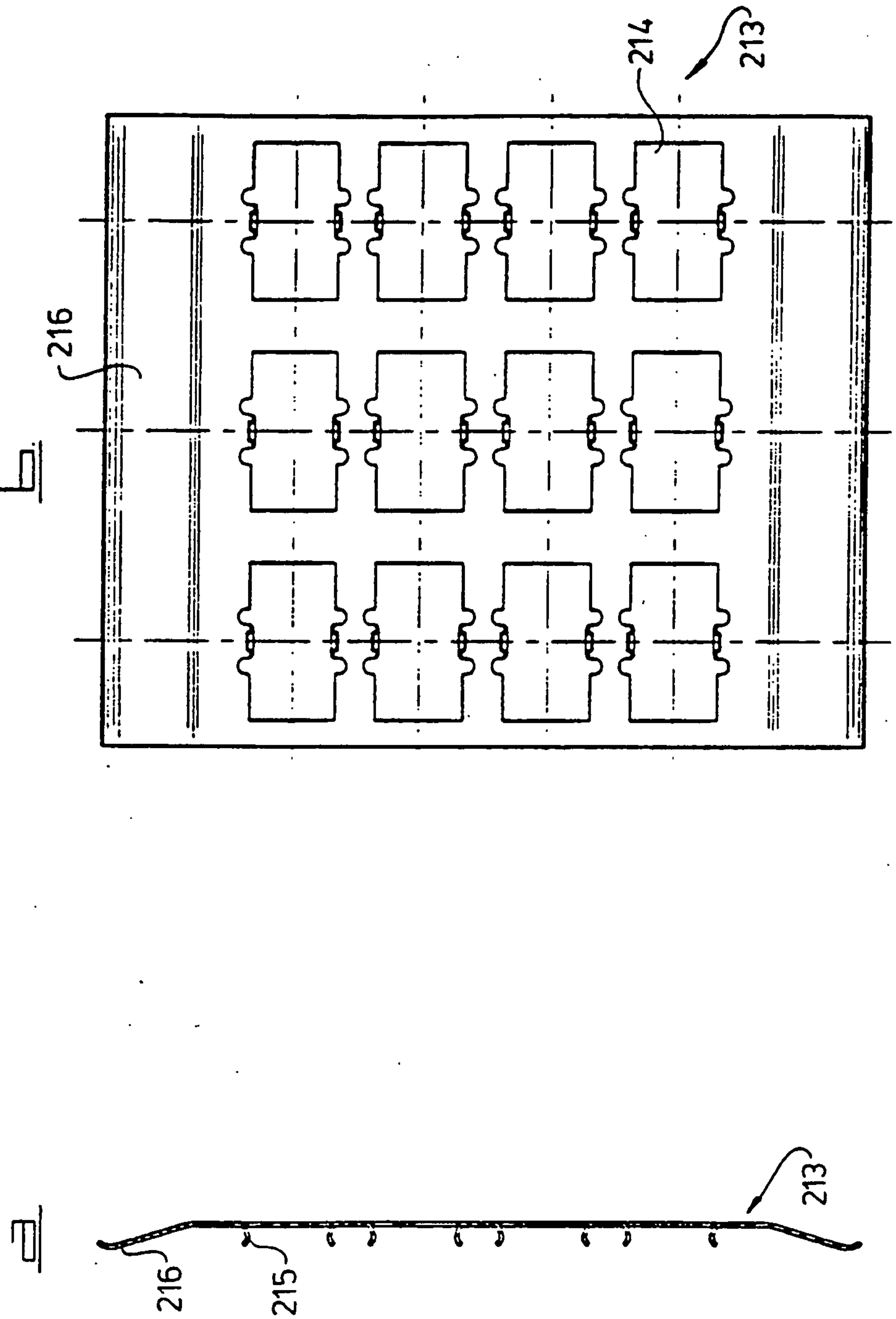


Fig-12

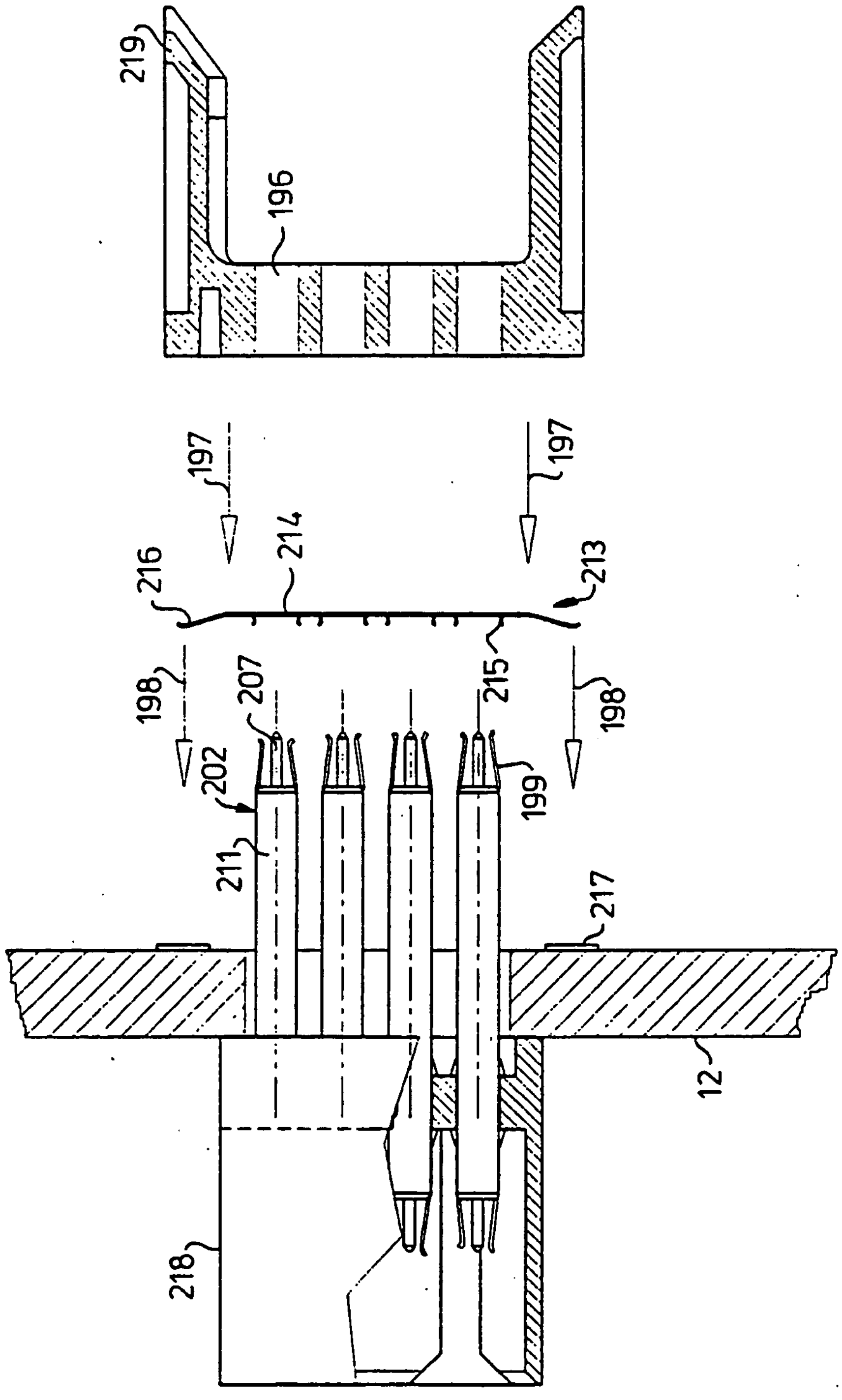

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Fig-13

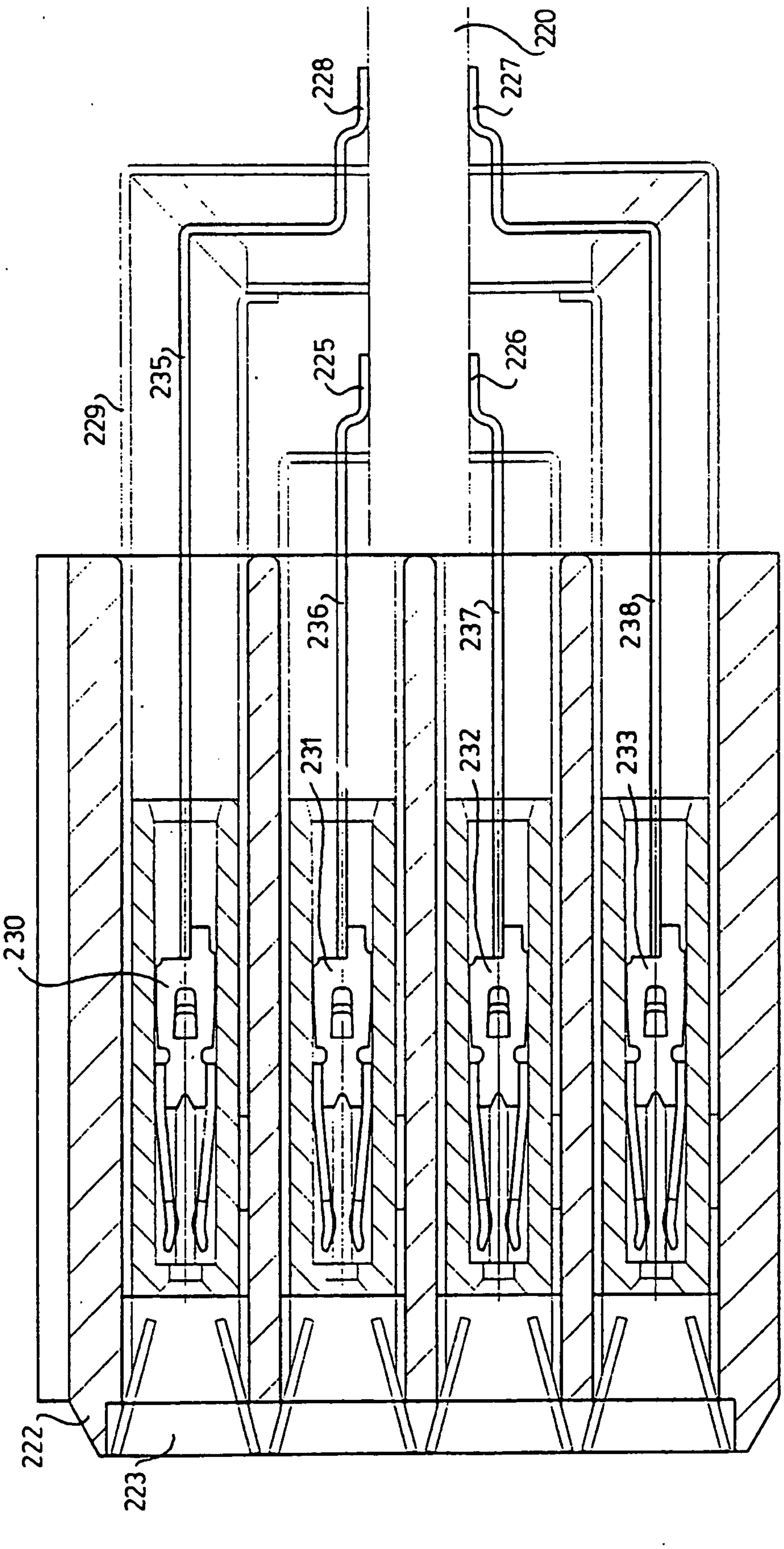

Fig-14

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 H01R13/28 H01R17/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,3 958 851 (EVANS) 25 May 1976 cited in the application	1
A	see column 2, line 42 - column 4, line 49; figures 1-7	5-8,10, 13
A	FR,E,89 154 (HENRI DURREMBERGER) 19 May 1967 cited in the application see the whole document	1-4,10
A	EP,A,0 131 248 (W. L. GORE & ASSOCIATES, INC.) 16 January 1985 see page 3, line 19 - page 5, line 24; figures 1,2	1,7-10

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
28 March 1994	15 AVR. 1994

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Tappeiner, R

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NL 93/00275

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB,A,628 696 (STANDARD TELEPHONES AND CABLES LIMITED) 22 September 1949 cited in the application see page 1 - page 2, line 90; figures 1-8	1,10
A	DE,A,20 18 376 (INTERNATIONAL BUSINESS MACHINES CORP.) 12 November 1970 see page 11, last paragraph - page 17; figures 1-5	1,9,10
A	EP,A,0 450 909 (AMPHENOL CORPORATION) 9 October 1991 see page 3, column 2, last paragraph - page 5, column 6, line 29; figures 1,2	11
A	EP,A,0 458 483 (THOMAS & BETTS CORPORATION) 27 November 1991 see page 3, column 3, line 23 - page 4, column 5, line 32; figures 1-7	12
A	EP,A,0 488 482 (E.I DU PONT DE NEMOURS AND COMPANY) 3 June 1992 see page 3, column 4, line 30 - page 5, column 8, line 46; figures 1-7	12

2

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-3958851	25-05-76	CA-A-	1038054	05-09-78
		DE-A,C	2557598	08-07-76
		FR-A,B	2296953	30-07-76
		GB-A-	1470159	14-04-77
		JP-C-	980921	18-12-79
		JP-A-	51079287	10-07-76
		JP-B-	54016033	19-06-79
FR-E-89154		NONE		
EP-A-0131248	16-01-85	DE-A-	3474382	03-11-88
		US-A-	4707040	17-11-87
GB-A-628696		NONE		
DE-A-2018376	12-11-70	FR-A-	2042949	12-02-71
		GB-A-	1244706	02-09-71
		US-A-	3587028	22-06-71
EP-A-0450909	09-10-91	US-A-	5118303	02-06-92
EP-A-0458483	27-11-91	JP-A-	4229580	19-08-92
EP-A-0488482	03-06-92	CA-A-	2056736	30-05-92
		JP-A-	4286885	12-10-92
		US-A-	5169343	08-12-92